

A SPATIO-TEMPORAL ANALYSIS OF CROP DIVERSIFICATION IN JAMMU PROVINCE (2007 & 2016)

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ABSTRACT

Jammu province has a subsistence agricultural based economy. Most of the region is hilly and mountainous. The cultivable land is quite limited due to physiographical variations, high variability of rainfall and less area under irrigation. By seeing these challenges the main focus on improving productivity and crop diversification towards high value crops seems to be suitable to enhance farmer's income and promote development in the region. This paper is an attempt to examine the extent of crop diversification and identification of potential regions in Jammu Province. This study is based on the secondary data. By using Gibbs Martin index of crop diversification which shows noteworthy patterns of crop diversification in the study area. To examine the determinants of diversification for identifying potential regions in the study area, a composite index is framed on the basis of variable index. The result shows huge variations in index of crop diversification by comparing the two time period i.e. 2007-08 and 2016-17. There are certain challenges and issues faced by the cultivators mainly proportion of irrigated area to gross cropped area, length of roads, rural literacy and rate of urbanization which needs to be addressed to promote better agricultural development in the study area.

KEYWORDS: Crop Diversification, Cropping Patterns & Variable Index and Agricultural Development

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INTRODUCTION

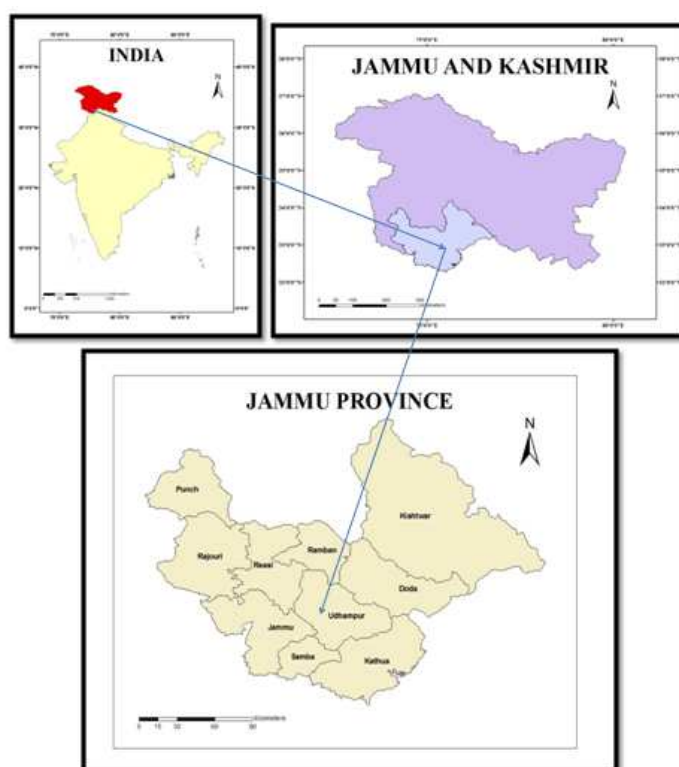
Agricultural growth is a multi-dimensional idea which embraces a variety of aspects such as agrarian land use, diversification in cropping pattern and crop concentration, productivity, cropping intensity, commercialization of agriculture, conservation of ecological balance and so on. Furthermore, agricultural planning has been acknowledged as suitable devices for planning enhancements in agriculturally under-developed or developing regions (David, 1969). For proper implementation of the agricultural planning program, agricultural regionalization in micro level is highly significant. In this context, crop diversification plays a noteworthy part. The stronger the rivalry, the higher the gradation of diversification, and smaller the competition, bigger will be the degree of specialization, or monoculture, (Husain, 2004). Crop diversification is essential for farmers to increase their income. This because high-value crops, like vegetables and fruits has higher productivity i.e. Rs1.4 lakh per hectare, related to Rs 40000 for chief staple crops in India (Mint, 2018). The main benefit of crop diversification is that it helps in forth coming planning and development of agriculture. In the above context, spatial as well as temporal arrangement of crop diversification is of high significance in understanding the current and shifting pattern of following struggle i.e. between crops in the study area, economically remunerative and ecologically sustainable crop rotation, soil fertility, ecological stability and enhancing productivity. The Jammu Province has 77.80 percent of population living in rural areas according to census 2011 and more than 80% of the total

population is indulged in agriculture and allied activities (Regional Digest Jammu Division, 2011). Therefore, such type of study is valuable for bureaucrats, planners as researchers to give more consideration to the uneconomical cropping system and to inspire economic agricultural planning as well as development. Consequently, an attempt has been undertaken to study the changing scenario of crop diversification during 2007-08 and 2016-2017 in Jammu Province.

STUDY AREA

Jammu province is the integral part of the state of Jammu and Kashmir. It is located in the southern part of state extending between $32^{\circ} 17'$ to $34^{\circ} 12'$ N latitudes and $73^{\circ} 58'$ to $76^{\circ} 47'$ E longitudes. The total geographical area of the province is 26293 sq. km spread over in 10 districts named as Jammu, Samba, Kathua, Reasi, Doda, Udhampur, Kishtwar, Poonch, Rajouri and Ramban (JKENVIS, 2011-12). The region is characterized by the distinctive topographical pattern whose altitude above sea level ranges from foot hill plains (below 366m) to Lesser Himalayas (3600-4600m). Chenab, Tawi and Ravi are the three major rivers flowing over the study area. Climatologically this study area experienced variation in rainfall and temperature and thus the region is sub- divided into two climatic zones, i.e. the plain region (in the south of the Siwaliks), and the mountainous region, outspreading from the Middle to the Greater Himalayas. The climate of Jammu province is mainly influenced by the periodic seasonal winds which blow from north to east direction in winters and south-west monsoons in summers due to the reversal of pressure takes place repeatedly twice in the year (Husain, 2000). Pedologically, the region composed of various types of soil groups like: Bhabar Soil, Brown, Red and yellow Soil, sub-montane soil, mountane meadow soil and Glacial Soil (Mir, 2002). By diverse climatic conditions as well as pedology, different type of agricultural crops. So this region has the potential and diversity in agriculture (Husain, 2004).

Location Map of Jammu Province



Source: Census Atlas, 2011

Figure 1

OBJECTIVES

The main objectives of the study are as follows:

- To comprehend the spatial patterns and temporal variations of crop diversification in the study area.
- To examine various determinants related to crop diversification and to identify potential area on the basis of these determinants.

DATABASE AND METHODOLOGY

In the current study, an attempt has been made to examine the varying scenario of agricultural crop diversification in Jammu Province. The present study is based on secondary data and is empirical in nature. The required data for the year 2007-08 and 2016-17 have been attained from Digest of Statistics 2016-17, Directorate of Economics & Statistics Government of Jammu & Kashmir. For spatial analysis of crop diversification, crop varieties like food crops, cash crops, and non-food crops has been considered for measuring crop diversification. The variable spatial pattern of crops has been examined by applying appropriate statistical and quantitative methods; the results have been represented with the help of Arc GIS and Microsoft office Excel.

The study of crop diversification as a measure of the intensity of crop in an area is considered to be a step ahead in determining the regional character of the distribution of crops to highlight the importance or domination of one crop over other. The Crop diversification is calculated by Gibbs Martin (1962) formula considering percentages of all crops (both food crops and non-food crops) of the total cropped area (Singh & Dhillon, 2004):

$$\text{Index of Crop Diversification} = 1 - \frac{\sum x^2}{(\sum x)^2}$$

Where X is the proportion of total cropped area occupied by each crop (in hectares)

The determinants of diversification from staple food to other crop have been identified. Pingali and Rosegrant (1995) has revealed evidence that diversification out of staple food was generated by quick scientific and technological changes in agricultural production, improved rural infrastructure and diversification in food demand. These determinants are: a) Proportion of irrigated area to gross cropped area, b) length of roads c) rural literacy and d) rate of urbanization (Bhattacharyya, 2008).

To examine the determinants of diversification for identifying potential regions in the study area, a composite index is framed on the basis of variable index which is prepared by following formula (Organization for Economic Co-operation and Development, 2008):

$$I = \frac{X_i - \min(X)}{\max(X) - \min(X)}$$

Where

‘ X_i ’ -: value variable for an i^{th} district and at given time.

min (X) and max (X):- the minimum and the maximum value of ‘ X_i ’ across all districts at particular time.

‘I’:-means variant of the Min-Max whose values lying between 0 and 1 (OECD, 2008).

The analysis of diversification with a tabular analysis showing the shift in area as well as production of the

different crops produced in the state. It is followed by the correlation results are presented which gives a broad idea of the determinants affecting crop diversity in the province and finally by a comparative study of the determinants and crops diversification.

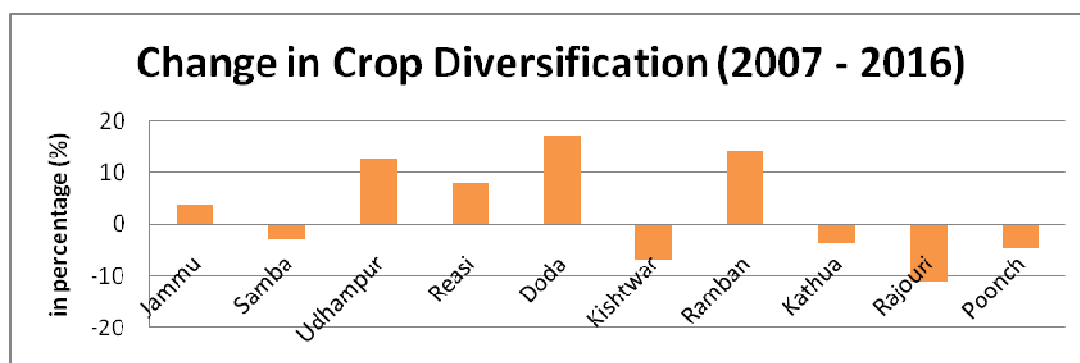
RESULTS AND DISCUSSIONS

The present paper is an attempt to analyze the spatio-temporal change of crop diversification in Jammu Province by taking into the consideration of crop diversification index and four indicators namely proportion of irrigated area to gross cropped area, length of roads, rural literacy and rate of urbanization for assessing the potential regions.

Spatio-Temporal Patterns at District Level

Table 1: Index of Crop Diversification and Change in Magnitude of Crop Diversification During Study Period 2007-08 and 2016-17

S. No.	District	Index of Crop Diversification (2007-08)	Index of Crop Diversification (2016-17)	Change in the Magnitude of Crop Diversification	Percentage Change in Crop Diversification
1	Jammu	0.672	0.698	0.026	3.87
2	Samba	0.711	0.69	-0.021	-2.92
3	Udhampur	0.602	0.677	0.075	12.55
4	Reasi	0.542	0.587	0.045	8.21
5	Doda	0.541	0.635	0.094	17.22
6	Kishtwar	0.678	0.632	-0.046	-6.85
7	Ramban	0.505	0.577	0.072	14.29
8	Kathua	0.727	0.701	-0.026	-3.63
9	Rajouri	0.65	0.578	-0.072	-11.09
10	Poonch	0.619	0.59	-0.029	-4.66



Source: Regional Digest of Statistics J&K, 2007-08 & 2016-17.

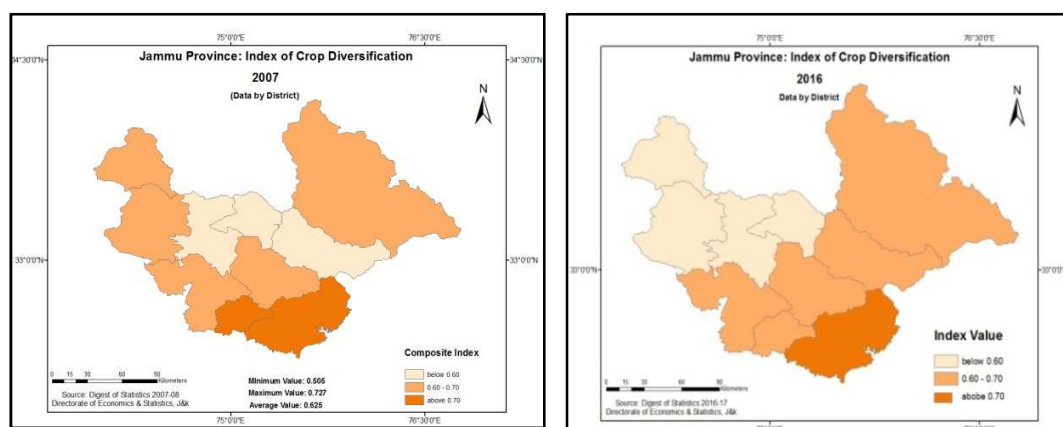
Figure 2

Spatio- temporal variation of crop diversification shows changes in agriculture over time. Jammu Province has a very good level of index of crop diversification (ICD) for both 2007-08 and 2010-11 temporal period. In spatial context there is a great range of crop diversification value among all districts of the study area. The study has classified region into high, moderate and low level of crop diversification to detect the variation of crop production. Table-1 has shown the district-wise index of crop diversification exclusively. Including all districts result, the average ICD value of the entire district during 2007-08 was 0.70 while it was 0.73 during 2016-17. So it must be stated that degree of crop diversification is to some extent increased due to diversified agriculture. Percentage of area underbajra, has decreased by 17%, area of

Barley has decreased by 34%, area under wheat cultivation has only increased by 3%, whereas proportion of area under non-food crops has increased but there is an increase other food crops and horticulture in the time period taken. However, more changes have been observed at district level during 2007 to 2016.

Table 2: Identification of Districts under Different Level of Crop Diversification in 2007 and 2016

S. No	Categories of Districts	Index of Diversification	2007			2016		
			Name of Districts	Total Number of Districts	Percentage of Districts	Name of Districts	Total Number of Districts	Percentage of Districts
1	Highly Diversified	above 0.70	Kathua, Samba	2	20%	Kathua	1	20%
2	Moderately Diversified	0.60-0.70	Jammu, Udhampur, Rajouri, Poonch, Kishtwar	5	50%	Jammu, Udhampur, Doda, Samba, Kishtwar	5	50%
3	Least Diversified	below 0.60	Reasi, Doda, Ramban	3	30%	Reasi, Ramban, Rajouri, Poonch	4	40%



Source: Regional Digest of Statistics J&K, 2007-08 & 2016-17.

Figure 3

After calculating the crop diversification index the study can be categorized into three regions:

Area with High Crop Diversification (above 0.70)

The region of high crop diversification is formed in the southern part of the study area which comprises of two districts namely Kathua (0.727) followed by Samba (0.711 ICD value) in the 2007-08. However, in 2016-17, the southern part remains at higher crop diversification level but area shrinks to one district in this category i.e. Kathua district (0.701). So, there is a decrease in the number of highly diversified districts. The table 2 clearly shows that the southern part of the state is the highly diversified in both 2007 and 2016. This is due to the influence of Punjab and more accessibility to the rest of the country. As there is stronger rivalry so there is gradation of diversification. However, the most important change during the time is the both Samba and Kathua which fall under the high category in 2007 and both show a negative growth in the ICD value i.e. -2.92% and -3.63% in during the course of time. This is due to the increase in the area under rice cultivation by 12% southern region (Regional Digest of Statistics, J&K).

Area with Moderate Crop Diversification (0.60 to 0.70)

In 2007, the region of moderate crop diversification is found in the eastern, western and central part of the study area which comprises of 5 districts namely Jammu, Udhampur, Poonch, Rajouri and Kishtwar. While in 2016-17 the region having moderate crop diversification forms a contiguous belt extending from north-east to south-west direction of the study area. The region comprises of 5 districts namely Jammu, Udhampur, Doda, Samba, and Kishtwar. The index value ranges between as low as 0.632 in Kishtwar district and as high as 0.698 in Jammu district. Here, the diversification level of Samba decreases from high to moderate category. The Jammu, Udhampur and Kishtwar who might remain in the same category but had experienced a change in the ICD value where Jammu and Udhampur experience a positive growth of 3.87% and 12.55% but Kishtwar experience huge downfall in the diversification index value of -6.85%. This is due to the fact that the both Jammu and Udhampur experience growth in roads and infrastructure facilities and high value crops had good demand. Thus, Jammu district experience negative growth share in the area under food crops like: bajra and wheat on the other hand there is increase in the proportion of area under horticultural crops and oilseeds in Jammu districts. Similarly, Udhampur also, experience increase in the proportion of area under horticultural crops. But the biggest improvement is seen in the Doda district which shows a tremendous improvement in the ICD value i.e. from 0.54 to 0.63 which increased at 17% from 2007 to 2016 (Regional Digest of Statistics J&K, 2016-17) and thus, moves from low to moderate level of crop diversification.

Area with Low Crop Diversification (Below 0.60)

There is a change in spatial pattern of Jammu province in this category as in 2007 the central part of the study is least diversified but now in 2016-17 north-western part of the state has least crop diversification index. The results after investigating the 2007 -2008 dataset shows that Reasi, Doda, Ramban district are under the low category and ICD values in these districts are 0.542, 0.542 and 0.505 respectively. Only maize crop in summers and wheat crop in winters is the dominant one practice as the region has less irrigation facilities and less fertile soil so monoculture is dominated in the region (Regional Digest of Statistics J&K, 2007-08). In 2016-17, Reasi, Ramban, Rajouri and Poonch district are under the category of low ICD. Here, the Ramban and Rajouri district are least diversified and their ICD value is 0.577 and 0.578 respectively. From 2007 to 2016, the Reasi and Ramban improves a lot and show positive trends i.e. 8.21% and 14.29% increase in ICD value respectively. Whereas district Poonch and Rajouri who previously falls in the Class 2 are demoted to Class 3 and show -4.66% and -11.09% decline respectively. As all the 4 districts in 2016-17 are the remotest districts and lacks basics agriculture infrastructure, poor irrigation facilities, poor transport facilities so the farmer of these region perform monoculture as the region is dominated with maize cultivation. Overall, mixed scenario is observed in the crop diversification index as 5 districts showed positive trend and 5 district has negative trend during study period 2007- 08 to 2016-17.

Relationship between Various Parameters and Index of Crop Diversification

To study the forces which are prompting the diversification in the province, a number of descriptive variables are studied. Crop Diversification is influenced by a number of factors both from the supply side as well from the demand side. The variables considered for this study are proportion of irrigated area to gross cropped area, length of roads, rural literacy and rate of urbanization.

Table 3: Relationship between Various Parameters and Index of Crop Diversification

S. No.	Variables	Correlation Coefficient	Result
1	Length of roads	0.480269	Positively correlated
2	Rural Literacy	0.716831	Positively correlated
3	Rate of Urbanization	0.665507	Positively correlated
4	Proportion of Irrigated area to gross cropped area	0.779946	Positively correlated

Source: Regional Digest of Statistics J&K, 2016-17.

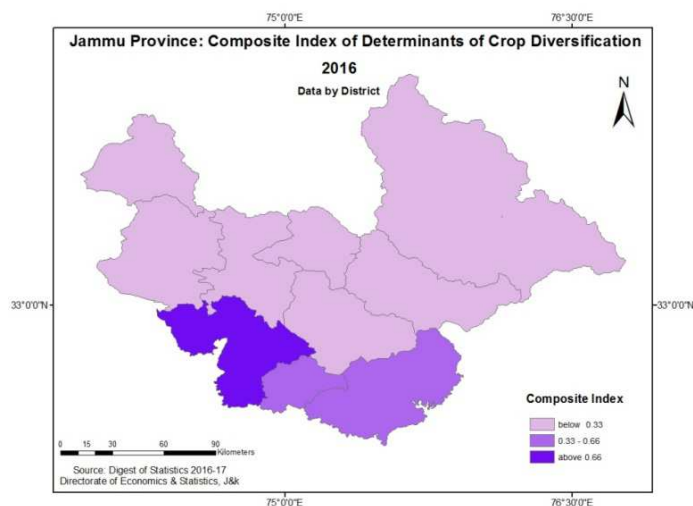
The correlation results show that all the four variables which are selected in the Table 3 have a positive and significant effect on the degree of diversification. This means that crop diversification is taking place in the study area as the region is mainly the rain fed where the agriculturalists are unable to cultivate the staple crops like rice that requires plenty of water throughout and have fewer resources. The development of infrastructure consequently plays a significant role in boosting diversification. This is reflected in the positively correlated coefficient of road. Better road network actually encourages diversification in favour of horticulture commodities as it requires lower transport cost, easy, faster transportation and quick disposal of products. It also decreases post-harvest risk of losses in case of perishable items. Urbanization has strong effect on the degree of diversification as it is a demand based factor. With the shifting food habits of the people the demand for high value crops increases. In the recent years food consumption is shifting from cereals to non-cereals in both rural and urban areas with a remarkable change in favour of fruits (Bisail, Chatterjee, Sau, Samanta, and Saha, 2016).

All the determinants now have a positive impact on the degree of diversification. Of the entire factors proportion of irrigated area to gross cropped area has a tremendous effect on diversification. In other words proper irrigation facilities boost the production of boost high value crops like fruits and other cash crops. Rural literacy is another crucial determinant. As the result of urbanization, structure of consumers demand for food is changing. For example, due to rising concerns for dietary health, the market for non-traditional fruits and vegetables has extended swiftly over recent years which will enhance the nutritional balanced diet. These changes in consumption configurations occur not only in developed countries but also in both urban as well as rural areas of developing countries. The above discussion shows that good road infrastructure could inspire agricultural diversification as they help capitalizing on profit and minimize uncertainty in the output prices. Absence of strong infrastructure may deprive farmers to take possible opportunities for cultivating high value crops (Bhattacharya, 2008).

Table 4: District-Wise Composite Index of Various Determinants and Index of Crop Diversification in Jammu Province, 2016-17

S. No	Districts	Length of Roads	Rural Literacy	Rate of Urbanisation	Proportion of Irrigated Area to Gross Cropped Area	Composite Index	Index of Crop Diversification (2016)
1	Jammu	1	0.943228	1	1	0.99	0.698
2	Samba	0.122895	1.005937	0.27596	0.500496	0.48	0.69
4	Udhampur	0.197685	0.393321	0.334642	0.143707	0.27	0.677
5	Reasi	0.057671	0.11243	0.096422	0	0.07	0.587
6	Doda	0.039415	0.36846	0.083115	0.018038	0.13	0.635
7	Kishtwar	0	0.043043	0.049738	0.201784	0.07	0.632
8	Ramban	0.024517	0	0	0.009713	0.01	0.577
3	Kathua	0.330117	0.668275	0.226658	0.552032	0.44	0.701

Table 4: Contd.,							
9	Rajouri	0.357557	0.489054	0.086824	0.048761	0.25	0.578
10	Poonch	0.136443	0.440074	0.085951	0.127651	0.2	0.59



Source: Regional Digest of Statistics J&K, 2007-08 & 2016-17.

Figure 4

The Table 4 clearly shows that the southern part of the Jammu Province has better potential of crop diversification comprises of 3 districts i.e. Jammu, Samba and Kathua. The Jammu had the highest composite index value of 0.99 followed by Samba (0.48) and Kathua (0.44). All these districts had better road infrastructure, high urbanization level which act as a source of high demand. The other factors include high irrigated area which supports high value crops that require more water like horticultural crops. Furthermore, high literacy among rural population in the southern region helps the cultivators to aware about new technologies. On the other hand, the remaining part of the study area comprises of 7 districts which located in the eastern, western and northern part owing to worse performance in all the taken determinants. Among all these districts Ramban (0.01), Reasi (0.07) and Kishtwar (0.07) are worse performers and require improving above mentioned determinant of crop diversification. For improvement in crop diversification, it must be achieved by attention given towards all these determinants to boost crop diversification in those districts which are lacking behind so that farmer can get better returns in the region.

CONCLUSIONS

From the analysis of crop diversification the following conclusions may be drawn:

- Spatio- temporal variation of crop diversification shows Jammu Province has a very good level of crop diversification (ICD) for both 2007-08 and 2010-11 period. So it must be stated that degree of crop diversification in some extent increased due to diversified agriculture. Percentage of area under staple crops like: bajra and barley has decreased significantly in the area, whereas proportion of area under non-food crops has increased mainly in horticulture and oilseeds in the time period taken. However, most of the changes have been observed at district level during 2007 to 2016.
- Temporal variation shows that 50% of districts show positive changes in the status of diversification in cropping and other half of the districts show increase in crop intensification. Here, study area shows negative change

mainly due to increase in proportion of area under rice cultivation (nearly 10%) in southern region and maize cultivation in western region (by 7 percent).

- Spatially southern part of the study area is highly diversified from other part of the region. Also, all the selected determinants related to crop diversification are very much stronger in the southern part. However, northern part of the study area deprived of basic agricultural infrastructure and is quite remote area with respect to other parts of Jammu Province. Thus, experience low crop diversity.
- There is a wide range of crop diversity among various districts and temporal variation is also noteworthy, but overall result of ICD value is not so high where there is less concentration of population.
- Moreover, concentration of wheat and maize cultivation is very high for most of the region. Such intensive wheat and maize culture without suitable crop rotation consuming valuable resources like costly chemical fertilizers, and pesticides is not economically fruitful, and not ecologically balanced.
- The southern part of the region also had better road infrastructure, high urbanization as a source of high demand, high irrigated area which can support high value crops that require water mainly horticultural crops and high rural literacy which is easily exposed to new technologies. Thus, the southern part has better potential in improving crop diversification.
- Therefore, immediate necessary action plan should be carrying out for these districts so that the diversification of crops would reach in a reasonable mark regarding technical but eco-friendly techniques. Scientific crop diversification with relative, justified shares of different crops would make a satisfactory solution for these districts. Along with government policies, local people must come forward to change intensive and subsistent agricultural scenario.

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